Small electric motor, components therefor and method of manufacturing same

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Abstract of **GB2159078**

A method of manufacturing a small electric motor in which a mounting plate 3 is firmly secured to a yoke part 1 with precise alignment therebetween and without lowering the magnetic efficiency of the yoke. Angular projections 3a are formed on the mounting plate 3 by bending. The projections 3a are inserted into apertures 1b in the yoke part 1 which are formed when pole teeth 1a, are cut and bent out of the yoke part 1. The projections 3a are then deformed with a jig and a press tool to secure the mounting plate 3 to the yoke part 1.

FIG. 2

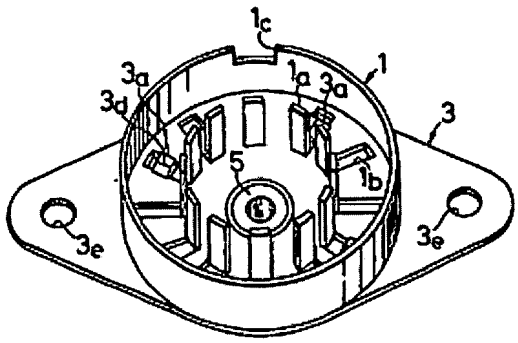
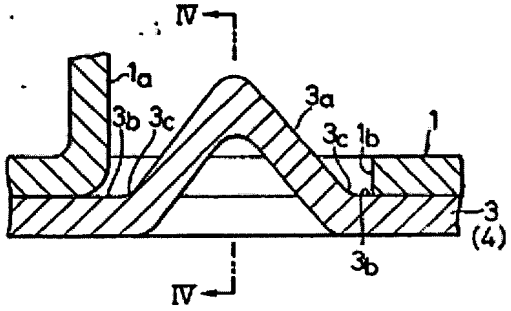


FIG. 3



Small electric motor, components therefor and method of manufacturing same

Description of **GB2159078** Translate this text

SPECIFICATION
Small electric motor, component structures therefor and method of manufacturing same
The present invention relates to a small electric motor and components therefor and to a method for manufacturing such components and motors.

UK patent application 84 23232 ( ) describes methods of making stator structures for use in a small electric motor and the present invention seeks to improve on these methods.

The present invention provides a method of producing a stator housing structure for an electric motor; said method comprising producing a first component having a plurality of pressed projections with inclined side flanks extending outwardly from a first face thereof, producing a second component having a plurality of rectilinear apertures in a wall thereof by a pressing operation to provide at one end of each aperture an upstanding lug for acting as a pole tooth, arranging the wall of the second component on the first face of the first component so that the projections engage through some of the apertures and terminate above a first surface of the base wall remote from the first face, locating the components with a jig and deforming the projections with a complementary press tool to cause the projections to engage tightly on the first surface of the wall of the second component thereby to unite the components while supporting the components with the jig to prevent undesired deformation other than to the projections.

The width of the projections is preferably substantially the same as the apertures to ensure good location between the components. However for each pair of adjacent projections the projections may be made to locate with opposite sides of a respective pair of apertures. Conveniently, the components have central regions which lie on an axis of a rotor in the assembled motor and which may receive a bearing. The apertures are then disposed radially of the wall and the projections locate at outer portions of the apertures.

In one practical realization of the invention the jig is made to engage on a face of the first component remote from the first face thereof and engages within at least one of the projections with at least one protrusion. In another arrangement the jig is made to engage with the second component, the jig has at least two protrusions with a first height, which are made to engage in respective pair of apertures and an aperture therebetween receives a projection of the first component and another protrusion of the jig having a height less than said at least two protrusions of said first height which cooperates with the press tool to deform the said projection.

In one construction the first component is a side mounting plate and the second component is a cup-shaped yoke part with the wall and an upstanding rim. Two such structures are then assembled with their rims facing one another to a pair of plate or disc like yoke parts which lie therebetween. The latter parts can be joined in the same manner i.e. with deformed projections engaging in apertures created by cutting and bending pole teeth. Bearings are mounted to the mounting plate or parts associated therewith and preferably project outwardly from the overall assembly. Exciting coils in the housing structures and a rotor carrying a magnet supported by the bearings then complete the motor.

In another construction a housing structure composed of a side mounting plate and a cup-shaped yoke part with a wall and an upstanding rim united as aforesaid or described hereinafter is assembled to a side structure composed of another side mounting plate and a plate like yoke part. This latter yoke part also has apertures with pole teeth and deformed projections of the mounting plate secure these components together. Bearings are again provided in the mounting plates or parts associated therewith to rotatably support a magnetic rotor.

Reference is made to the accompanying drawings, wherein;
Figurel is a sectional side view of a small motor to which the technical concept of the invention can be applied;
Figure 2 is a perspective view showing a structure composed of a cup-shaped yoke part and a mounting plate for use in the motor;
Figure 3 is a sectional side view showing part of the mounting plate of Figure 2 which is being secured to the cup-shaped yoke part, the view being taken on a somewhat larger scale to that of Figure 2;
Figure 4A is a sectional view taken along a line
IV-IV of Figure 3 during assembly of the components with a jig and press tool;

Figure4B is a bottom view of the press tool shown in Figure 4A;
Figure 5 is a plan view of one of the joints produced by deformation as shown in Figures 3 and 4;
Figure 6A depicts a modified press tool;;
Figure6B is a plan view showing one of the joints produced by deformation with the tool shown in Figure 6A;
Figure 7 is a sectional view showing the formation of another joint by a modified jig;
Figure 8 is a perspective view showing a structure composed of a plate-shaped yoke part and a mounting plate used in another motor; and
Figure 9 is a plan view depicting an alternate technique for positioning the yoke part and the mounting plate with respect to one another.

Figure 1 shows a stepping motor constructed in the manner generally described in UK patent application 84 23232. In this construction, two cupshaped yoke or stator housing parts 1 are combined with two respective plate-shaped yoke or core parts 2 to provide a stator assembly. Mounting plates 3 and 4 are secured to the outsides of the cup-shaped yoke parts 1. Figure 2 shows one of the cup-shaped yoke parts 1 with an associated mounting plate 3. A shaft 6 is rotatably supported by bearings 5, one of which is mounted directly to the left hand mounting plate 3 and the other of which is mounted to a pressing. A rotor magnet 7 is fixedly mounted on the rotary shaft 6, and exciting coils 8 are provided in respective chambers defined by the yoke parts 1, 2.The cup-shaped yoke parts 1 and the plate-shaped yoke parts 2 have rectangular apertures 1b, from which extends lugs acting as pole teeth 1a and 2a which engage with one another. If the bearings 5 protrude from the motor as shown in Figure 1, the pole teeth 2a can be effectively confronted with the rotor magnet 7.

This technique is suitable for an elongated stepping motor where the diameter of the rotor is made as small as possible to reduce its moment of inertia. However, the torque thereof should not be decreased, that is, high speed operation should be maintained even if the diameter is made small. In order to meet this requirement, the bearings are made to protrude from the motor so that the pole teeth 2a are, in their entirety, confronted with the magnet 7. According to the user's specification, the positions of mounting holes 3e formed in the mounting plate 3 in Figure 2 may be angularly changed with respect to the stopping position of the shaft 6 as determined by the positions of the pole teeth 1a. Also the position of a recess 1c formed in each of the cup-shaped yoke parts 1 to receive the lead wires of the exciting coils 8 can also be varied.In the above-described embodiment, the pole teeth la, and accordingly the aperturesib, are formed at equal angular intervals, and the positions of the mounting holes 3e may be changed at will.

As shown in Figure 3, each of the mounting plates 3 and 4 has a plurality of projections 3a each of which is formed by pressing the mounting plate 3, 4 in such a manner that it is deflected above the flat surface 3b at zones 3c. As shown in
Figures 2 and 3, by way of example, the projections 3a of the plate 3 are inserted into the apertures 1b which are formed in the associated cupshaped yoke part 1 when the pole teeth 1a are created. Each hole 1b is substantially equal in width to each projection 3a so that, after the projections 3a are engaged within the apertures 1b, rotational movement therebetween is prevented. To firmly lock the projections 3a into the apertures 1 b, the projections 3a are deformed from above to overlap the sides of the respective apertures 1 b.The yoke part 1 has a relatively small amount of material with a flat area because of a number of apertures 1b formed therein. Therefore, the projections 3a cannot be reliably fixed merely by deformation as described in UK patent application 84 23232 because the yoke part 1 in particular will tend to be partially deformed during the fixing operation.

However, this difficulty can be overcome by adopting a supportive jig. As shown in Figure 4a deformation of the projection 3a is performed with a jig 9 and a complementary press tool 10. The lower jig 9 has a planar region supporting the underside of the plate 3 and a portion 9a which engages within the opening of the projection 3a. The upper tool 10 has inclined surfaces 10a and10b which engage with the upper portion of the projection 3a.

The latter are thus deformed, as indicated at 3d in
Figure 4, so that they are spread over the edges of the aperturesib, as shown in Figures 2, 4 and 5.

By shaping the tool 10 as a cylinder having a spherical end surface 10a as represented in Figure 6A, a shallow recess 3f can be formed in the top of the projection 3a as shown in Figure 6B to thereby effect tight sealing. In order to prevent the pole teeth la from being bent, it is desirable that each projection 3a be positioned as far from the associated pole tooth 1a in the corresponding aperture 1b as possible and that the deformation force be applied circumferentially.

The jig 9 and press tool 10 can be modified and operationally inverted as shown in Figure 7. In this modification, the yoke part 1 is placed on the jig 9 in such a manner that a shallow protrusion 9b of the jig 9 is located in the aperture 1b of the yoke part 1 into which one of the projection 3a of the mounting plate 3 is

to be inserted. Protrusions 9a of the jig 9 of somewhat greater height are simultaneously inserted into two adjacent holes Ib' on both sides of the hole 1 b of the yoke part 1 into which the projection 3a of the mounting plate 3 is inserted. The mounting plate 3 is next placed on the yoke part 1 in such a manner that each projection 3a is inserted into the corresponding aperture 1b. Under this condition, the upper tool 10 is successfully lowered within each projection 3a to deform the latter in cooperation with the shallow protrusion 9b of the lower jig 9.By inserting the protrusions 9a of the jig 9 into the two apertures 1b' on both sides of the apertures 1b into which a projection 3a is inserted and deformed in this manner unnecessary deformation of the yoke part 1 can be avoided.

The mounting plates 3, 4 are fixedly secured to the yoke parts 1 by deformation, that is, each projection 3a is inserted into a respective aperture 1b and is deformed so as to be fixed to the yoke part 1 as described above. Because the apertures 1b are created by cutting out the pole teeth 1a it is thus unnecessary to provide additional holes for receiving the projections 3a, and according to the magnetic efficiency of the yoke is not disturbed.

Moreover since quite a number of apertures 1 b are formed when the pole teeth 1a are formed, those used for receiving the projections 3a can be freely selected. Furthermore, as the apertures 1b have a reasonably precise width, the apertures 1b can be readily aligned with the projections 3a. The yoke parts 2 can be united in a similar manner and can take the form shown in Figure 4 of UK patent application 84 23232.

In the case where the invention is applied to an induction motor, a yoke assembly similar in configuration to the cup-shaped yoke part 1 and plate 3 in Figure 2 is fixedly secured to another assembly which is formed by combining the mounting plate 4 and a flat-shaped disc-like yoke part or plate 2 illustrated in Figure 8. In Figure 8, pole teeth 2a of the yoke plate 2 are bent radially inwardly from the apertures 2b which receive projections 4a of the mounting plate 4 deformed in the manner described above for the projections 3a. The teeth 2a may be bent radially outwardly instead of inward as shown. The associated bearing 5 may be provided on either the mounting plate 4 or the plateshaped yoke part 2.

In the above-described embodiments, the yoke parts 1 and 2 are fixed to the mounting plates 3 and 4 by deformation of the projections 3a and 4a.

The yoke part 1, 2 and the mounting plate 3, 4 are initially positioned with respect to each other merely by inserting the projections 3a, 4a into the respective apertures 1b, 2b but if this is not suitable, the yoke part 3, 4 and the mounting plate 3, 4 may also be joined together in other ways, for instance, by welding. However since the projections 3a, 4a are equal in width to the apertures 1b, 2b a reasonably accurate location is ensured. If the projections 3a, 4a are not equal in width to the apertures 1b, 2b the yoke part 1, 2 and the mounting plate 3, 4 can be prevented from rotating with respect to one another by positioning them as shown in Figure 9. As shown in Figure 9 the yoke part (here 1) and the mounting plate (here 3) are positioned in such a manner that the left side on one projection 3a-3c abuts against the left side wall of one aperture 1 b, and the right side of the another projection 3a-3c abuts against the right side wall of the other aperture 1b.

FIG. 1

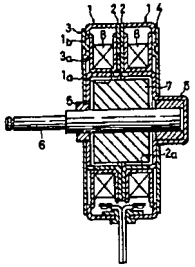


FIG. 2

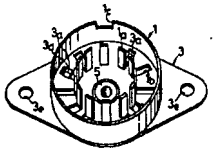


FIG. 3

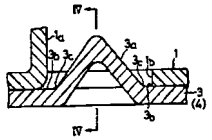


FIG. 4A

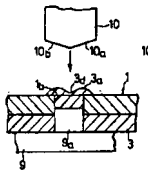


FIG. 4B

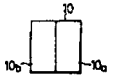


FIG. 5

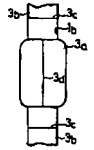


FIG. 6A

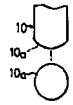


FIG. 6B

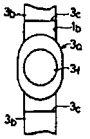


FIG. 7

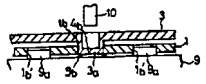


FIG. 8

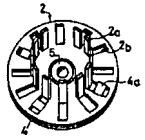


FIG. 9